REMARKS/ARGUMENTS

Claims 1-3 are pending herein. Claims 1-3 have been amended hereby to correct matters of form and for clarification purposes only. The specification has been amended by the substitute specification attached hereto as Appendix B, and the changes are shown in the marked-up specification attached hereto as Appendix C. Applicants respectfully submit that no new matter has been added.

1. Applicants affirm the provisional election with traverse to prosecute the claims of Group I (claims 1-3). Claim 4 has been withdrawn from consideration as being drawn to a non-elected invention, and thus has been cancelled without prejudice or disclaimer. Applicants reserve the right under 35 USC §121 to file a divisional application for the non-elected claim.

2. The objection to the drawings is noted, but deemed moot in view of the amendment made to Fig. 6. As shown on the amended drawing replacement sheet attached hereto in Appendix A, the legend --PRIOR ART-- has been added to Fig. 6.

For at least the foregoing reasons, Applicants respectfully request that the above objection be reconsidered and withdrawn.

3. Claims 1-3 were rejected under §103(a) over Scott '889 in view of Scott '949. Applicants respectfully traverse this rejection.

Independent claim 1 recites a discharge vessel or chamber for a high-intensity discharge lamp comprising a central body having a discharge space provided therein, two capillaries closing off respective end openings of the central body, and a pair of electrodes positioned within a respective one of the capillaries. The central body and the capillaries comprise an alumina material or an alumina-based ceramic material, and the average diameter of alumina grains in the capillaries is in a range of 10 μm to 25 μm.

Applicants respectfully submit that there is no disclosure or suggestion in Scott '889 that the capillary (tubularly-shaped extension 26 of the polycrystalline alumina

end cap 14) has an average grain diameter in a range of 10 μm to 25 μm, as recited in claim 1.

Although the PTO did not address this point, the PTO did admit that there is no disclosure or suggestion in Scott '889 that the MgO content of the capillaries was 1.5 times greater than that of the central body (arc tube 12). Applicants respectfully submit, however, that this limitation is recited in dependent claim 2, which depends from independent claim 1.

Applicants respectfully submit that although the PTO attempted to rely on Scott '949 to overcome the admitted deficiency of Scott '889, the secondary reference also does not disclose or suggest that the capillary portion of the arc lamp has an average grain diameter in a range of 10 to 25 μm, as recited in claim 1. Since the primary reference also lacks any disclosure or suggestion of this feature of claim 1, Applicants respectfully submit that the PTO has not met its burden of showing that each and every element of independent claim 1 is disclosed or suggested in the prior art.

For at least the foregoing reasons, Applicants respectfully submit that all claims pending herein define patentable subject matter over. Accordingly, Applicants respectfully request that the above rejection be reconsidered and withdrawn.

4. Applicants respectfully request that the PTO acknowledge receipt and consideration of the references cited in the Information Disclosure Statement filed on June 6, 2001.

If the Examiner believes that contact with Applicants' attorney would be advantageous toward the disposition of this case, the Examiner is herein requested to call Applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

Respectfully submitted,

September 11, 2003

Stephen P. Burr
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Attachments:

Appendix A -Amended drawing replacement sheet
Appendix B - Substitute specification
Appendix C - Marked-up specification

SPB/NB/gmh

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~~Specification~~

~~Title of the Invention~~
HIGH PRESSURE DISCHARGE LAMP ARC TUBE AND METHOD OF PRODUCING THE SAME

Field of the Invention

The present invention relates to a discharge vessel or chamber for a high-intensity discharge lamp and particularly, to a discharge vessel or chamber having a capillary at each end thereof for holding ~~en~~ an electrode and a method of fabricating the same.

Background of the Invention

Ceramic ~~made~~ discharge ~~vessel~~ vessels or chambers for high-intensity discharge lamps are generally classified ~~into~~ as either an integral type where the ~~center~~ central body defining a discharge space and ~~the~~ a capillary for holding an electrode are integrally formed ~~integral~~ with each other ~~and~~, or an assembly type ~~which comprise~~, wherein the body and the capillary are separately fabricated ~~separately~~ as two different components and assembled together. In either type, as shown in the explanatory cross sectional view of Fig. 6, an electrode ~~is~~ fabricated by an electrode material 12 with a discharge electrode 14 made of tungsten or the like joining to the distal end of a current conductor 13 made of niobium, molybdenum, or the like ~~and~~ inserted into capillary 11 made of an alumina based ceramic material or an alumina material before the gap between the electrode and the capillary is sealed air-tightly with a frit sealer 15 made of a glass material.

The discharge vessel or chamber is then baked at its body and capillary simultaneously at a proper temperature.

As the discharge vessel or chamber of such a conventional capillary type is baked at a high temperature for increasing the permeability of light across its body, ~~it will be declined in the physical strength~~the physical strength tends to

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decline. In particular, when the capillary is joined and sealed with the electrode, it may possibly crack. It is hence essential for ~~prevention of~~preventing any ~~crack~~ cracks to control the frit sealer to a precise amount and increase the thickness or physical strength of the capillary.

However, ~~the~~ controlling ~~of~~ the amount of the frit sealer requires a highly ~~precision~~ precise technique while ~~the~~ increasing ~~of~~ the thickness of the capillary interrupts the down-sizing of a resultant discharge lamp.

It is thus an object of the present invention, in view of the above aspects, to provide a discharge vessel or chamber for a high-intensity discharge lamp capable of inhibiting ~~the~~ crack generation ~~of any crack~~ without controlling the frit sealer to a precise amount or increasing the thickness of the capillary and a method of fabricating the same.

Summary of the Invention

We, the inventors, have studied ~~on~~ the sintering ~~characteristic~~ characteristics of a ceramic where ~~the higher the sintering temperature, the greater~~ the diameter of grains in the ceramic becomes greater at higher sintering temperatures, thus decreasing the physical strength ~~or the lower the sintering temperature, the smaller~~and where the diameter of grains in the ceramic becomes smaller at lower sintering temperatures, thus increasing the physical strength. As a result, an improved discharge vessel or chamber of a capillary type ~~is~~ was developed which ~~is~~ minimized ~~in~~ the generation of cracks. ~~As defined in claim 1 of~~According to the present invention, a discharge vessel or chamber for a high-intensity discharge lamp having a ~~center~~ central body arranged providing a discharge space therein and two capillaries provided for ~~shutting up~~closing off both end openings of the body and accepting a pair of electrodes, respectively, is provided, wherein the ~~center~~ central body and the capillaries are made of an alumina material or an alumina-based ceramic material and the average diameter of alumina grains in the capillaries ranges from 10 micrometers to 25

micrometers.

~~As defined in claim 2 of the present invention, the~~The discharge vessel or chamber according to ~~claim 1~~the present invention may be modified, in which the capillaries contain an amount of magnesium oxide, yttrium oxide, zirconium oxide, scandium oxide, lanthanum oxide, or their combination, 1.5 times greater than that of the ~~center~~ central body.

~~As defined in claim 3~~Further, according to another embodiment of the present invention, the discharge vessel or chamber ~~according to claim 1~~ may be modified ~~in which~~such that the ~~center~~ central body and the capillaries are made of an alumina-based composition.

~~As defined in claim 4~~According to another embodiment of the present invention, a method of fabricating a discharge vessel or chamber for a high intensity discharge lamp which has a ~~center~~ central body arranged providing a discharge space therein and two capillaries provided for ~~shutting up~~closing off both end openings of the body and accepting a pair of electrodes respectively is provided comprising the steps of:_ forming the ~~center~~ central body and the capillaries from an alumina material or an alumina-based ceramic material; and sintering the ~~center~~ central body and at least ~~portions~~ a portion of each of the capillaries at different temperatures.

Brief Description of the Drawings

Fig. 1 is an explanatory cross sectional view of an electrode section of a discharge vessel or chamber for a high-intensity discharge lamp showing a first embodiment of the present invention~~;~~.

Fig. 2 is a diagram showing the ~~relation~~ relationship between the ~~dosage~~ amount of magnesium oxide, the average grain diameter, and the physical strength~~;~~.

Fig. 3 is a flowchart showing a procedure ~~of~~ for fabricating the discharge vessel or chamber shown in Fig. 1~~;~~.

Fig. 4 is an explanatory cross sectional view of an electrode section

showing a second embodiment of the present invention~~;~~.

Fig. 5 is an explanatory cross sectional view of an electrode section showing a third embodiment of the present invention~~; and~~.

Fig. 6 is an explanatory cross sectional view of an electrode section of a conventional discharge vessel or chamber for a high-intensity discharge lamp.

Description of the Reference Numerals or Symbols

1~~...~~: Discharge vessel or chamber~~,—~~; 2~~...~~: ~~Center~~Central body~~,—~~; 2a~~...~~: Opening~~.—~~; 2b~~...~~: Discharge space~~,—~~ ; 3~~...~~: Capillary~~,—~~; 5~~...~~: ~~Center~~ Central body~~,—~~; 6~~...~~: Plug~~,—~~; 7~~...~~: Capillary~~,—~~; 8~~...~~: Tubular member~~,—~~; 9~~...~~: ~~Center~~ Central body~~,—~~; 10~~...~~: Capillary~~,—~~; 10a~~...~~: Cover portion~~,—~~; 10b~~...~~: Capillary portion.

~~Best Modes for embodying~~Detailed Description of the Invention

Some modes for embodying the present invention will be described in more detail referring to the relevant drawings. Fig. 1 is an explanatory cross sectional view of ~~a~~ an electrode section of a discharge vessel or chamber of a high-pressure discharge lamp according to the present invention. The discharge vessel or chamber 1 comprises a ~~center~~ central body 2 having an opening 2a provided at each end thereof and a discharge space 2b defined therein and a pair of capillaries 3, each inserted into the opening 2a and having a tubular shape for accepting and holding an electrode material (not shown). The capillary 3 is doped with an amount of magnesium oxide substantially 20 times greater than ~~that~~ the amount of magnesium present in the body 2, and ~~its~~ the average diameter of alumina grains in the capillary 3 is decreased to be as ~~smaller~~ small as 19 micrometers ~~than~~ compared to 32 micrometers in the body 2 ~~for increasing~~to increase the physical strength.

The doping of magnesium oxide permits the average diameter to be decreased, thus improving the physical strength. Accordingly, the generation of cracks during the installation of the electrode material will be prevented. It is hence unnecessary ~~for the sealing~~ to measure a precise amount of the frit sealer

sealer ~~more than hitherto~~. It is also ~~not needed~~unnecessary to increase the thickness of the capillary, thus down-sizing the discharge lamp can be accomplished with much ease.

The ~~dosage~~ amount of magnesium oxide is not limited to 20 times greater than in the ~~center~~ central body but may be within a range of the ratio shown in the diagram of Fig. 2 ~~for~~ to maintain the ~~relation~~ relationship between the ~~dosage~~amount, the average grain diameter, and the physical strength. At the ratio where the capillary 3 is greater in the ~~dosage~~ amount of magnesium oxide than the ~~center~~central body 2, it can be smaller in the average diameter but higher in the physical strength than the ~~center~~central body 2. If the ratio is not greater than 1.5 times, the physical strength may hardly increase. When the ratio exceeds 25 times, the strength is not increased in proportion with the ~~dosage~~amount. Hence, the ~~dosage~~ amount is preferably within a range ~~from~~ of 1.5 times to 25 times. In Fig. 2, the horizontal axis represents the ratio in the ~~dosage~~ amount of magnesium oxide of the capillary 3 to the ~~center~~ central body while the bend strength is a ratio to the ~~center~~ central body.

A method of fabricating the discharge vessel or chamber will now be ~~descried~~ described referring to the flowchart of the procedure shown in Fig. 3. The ~~center~~ central body 2 and the capillary 3 are made of an alumina material or an alumina-based ceramic material. The procedure starts with forming the capillary 3 at Step 1 (S1). During this forming step, an amount of magnesium oxide, e.g. 20 ~~time~~ times greater than of the ~~center~~ central body 2, is doped. At S2, a green form is pre-baked at 1200 ℃ for three hours under ~~the~~ atmospheric conditions in a pre-sintering step. The pre-sintering is followed by inserting ~~at S3~~ the capillary 3 into the opening 2a of the ~~center~~ formed separately at S3 central body 2 ~~formed separately~~. Then, the assembly is ~~pre-based~~pre-baked at 1200 ℃ for three hours under ~~the~~ atmospheric conditions at S4. Finally, the same is ~~baked~~ fired at 1850 ℃ for three hours under ~~the~~ a hydrogen atmosphere at S5.

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The oxide dopant is not limited to magnesium oxide but may be selected from yttrium oxide, zirconium oxide, scandium oxide, lanthanum oxide, and ~~their combination~~combinations thereof. Those like magnesium oxide also permit the diameter of grains to be minimized and the physical strength to be increased. The ~~center~~ central body 2 and the capillary 3 may not be made of the same composition. Preferably, the capillary 3 may contain a metal material, which is used in the joint of an electrode material, in order to make its characteristic of thermal expansion equal to that of the metal material.

Fig. 4 is an explanatory cross sectional view of an electrode section showing the second embodiment of the present invention. A ~~center~~ central body 9 has an opening 9a provided at each of both, left and right (not shown), ends of a discharge space 9b thereof. Each of the ~~opening~~ openings 9a of the body 9 is ~~shut up~~closed off with a capillary 10 in which an electrode material (not shown) is inserted and secured by sealing. The capillary 10 comprises a cover portion 10a for closing the opening 9a of the body 9 and a capillary portion 10b extending outwardly and vertically from the center of the cover portion 10a.

A method of fabricating the second embodiment comprises the steps of forming the ~~center~~ central body 9 and the capillary 10 of an alumina material or an alumina-based ceramic material and after pre-sintering, sintering the ~~center~~ central body 9 at 1850–℃. The capillary 10 after being formed is pre-baked at 1200–℃ to 1400–℃. Then, both are joined to each other and ~~baked~~ fired at 1700–℃. The ~~joining is made by the~~ cover portion 10a is inserted into the opening 9a and shrunk-on ~~joining~~ to joint the capillary 10 to the ~~center~~ central body 9.

As the sintering temperature of the ~~center~~ central body 9 is 1850–℃ and that of the capillary 10 is 1700–℃, i.e. the ~~center~~ central body 9 is ~~baked~~ fired at the higher temperature, the average diameter of alumina grains in the ~~center~~ central body 9 can be increased to as great as 35 micrometers, hence increasing the permeability of light and improving the optical properties. On the other

hand, since the capillary 10 is ~~baked~~ fired at ~~the~~ a lower temperature ~~and~~, its average diameter of alumina grains can be as small as 25 micrometers. Using the sintering temperature of 1850~~-~~℃, the physical strength can be increased, for instance, from 29 kg/cm^2 to 38 to 45 kg/cm^2. This will prevent the generation of cracks ~~on~~ in the frit sealer during the sealing of the electrode. If the capillary 10 has an average diameter greater than 25 micrometers, its physical strength may be declined. When lower than 10 micrometers, the other properties including the resistance to corrosion may be degraded. Preferably, the average diameter ranges from 10 to 25 micrometers.

Fig. 5 illustrates a third embodiment of the present invention. A ~~center~~ central body 5 of a cylindrical shape has two openings provided in both ends thereof, each the opening ~~shut up~~closed off with a ring-like plug 6. A capillary 7 is inserted into the center hole of the opening. A tubular member 8 is fitted onto the capillary 7, thus forming a double-capillary structure.

The body 5, the plug 6, and the capillary 7 are assembled and joined by a conventional sintering method, such as a ~~shrunk-on~~shrink-fit method ~~of~~ by sintering at 1850~~-~~℃, which is based on a difference in the shrinkage. After the sintering step, the tubular member 8 is ~~fitted~~ fit onto the capillary 7 and subjected to a re-sintering process. For example, the tubular member 8 is ~~baked~~ fired at 1200~~-~~℃, ~~fitted~~ fit onto the capillary 7, and ~~baked~~ fired again at 1700~~-~~℃ ~~for shrunk-on joining~~to join with the capillary 7 in a shrink-fit manner.

This can increase the physical strength of the capillary, hence permitting a conventional arrangement of the discharge lamp to be increased in the physical strength and preventing the generation of cracks.

Applicability to Industries

As set forth above, according to the present invention ~~according to claims 1 to 3 allows~~, the capillary ~~to~~ can be improved in ~~the~~ physical strength thus minimizing the generation of cracks during the sealing of the discharge vessel or chamber and also contributing to the down-sizing of the discharge vessel or

chamber.

The method of the present invention ~~according to claim 4~~ allows the ~~center~~central body and the capillary to be ~~different in the sintering temperature~~sintered at different temperatures so that the average diameter of grains in the capillary can be smaller than that in the ~~center~~central body. As a result, the physical strength of the capillary can be increased thus preventing the generation of cracks ~~during the sealing~~when the capillary is sealed with the electrode.

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